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IN THIS ISSUE

FRONT COVER

Point Four Entomologist

A sanitary engineer and a field foreman examine a specimen of stagnant water for the presence of mosquito larvae. This entomological work is part of a Point Four program in Liberia to control malaria. (Photo by Technical Cooperation Administration.)

BACK COVER

Migration of the Locust

Along the locust's line of march in Africa and the Middle East, the United States works with other countries and with the Food and Agriculture Organization of the United Nations to bring the pest under control. (Map by Technical Cooperation Administration.)

NEWS NOTES

World Record Bread Grain Output Expected

World production of bread grains—wheat and rye—is expected to set an all-time high mark in 1952-53, exceeding the previous record by 10 million tons. A first forecast, based on information available to OFAR, places the probable bread grain output at 258 million short tons. The previous peak output was 248 million tons in 1937-38.

The apparent new record was made possible by a precedent-breaking wheat crop; the rye harvest probably will be below average. The sharpest increase in wheat production is in North America, where the harvest set a record. Canada's crop was its biggest ever, while United States production is the second largest in history. It is too early in the growing season for definite indications of the wheat and rye crops in the Southern Hemisphere. It seems likely, however, that output will be about average in South America. Australia's wheat crop should be somewhat less than in 1951-52. Australia grows relatively little rye.

In Europe's reporting countries wheat production is about 5 percent above the good 1951 outturn, with most of the increase in the two major producing countries, France and Italy. There was a decrease in the United Kingdom of 6 million bushels because of reduced acreage and smaller yields. In the Soviet Union growing conditions generally were favorable for wheat, and, with better harvesting weather than that of 1951, the wheat crop is expected to be at least up to 1951. The rye crop, however, may not be quite as good.

Asia's wheat harvest is estimated to be slightly larger than in 1951 and 8 per cent above prewar, while rye production about equals the record 1951 outturn.

Credit for photos is given as follows: pp. 172, 174, TCA; p. 181, Centro Nacional de Agronomía, El Salvador; p. 182, Frank J. Shideler; p. 183, William L. Pritchett.

FOREIGN AGRICULTURE — ALICE FRAY NELSON, EDITOR

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Entomology in Point Four*

by EDSON J. HAMBLETON

Simply stated, the basic purpose of all agricultural projects under the Point Four program of technical assistance is to help the people of other countries increase their food supply. This is possible in any underdeveloped country where certain changes can be easily introduced—changes such as improved seed, better preparation of the soil, adoption of more effective farming practices, and use of fertilizers and pesticides. It is with the pesticides that the entomologist is concerned. They are the weapons with which he fights insects and insect-borne diseases that cut the productivity of farmers and their livestock and with which he protects the crops in the field and the food in storage.

The entomologist knows that as crop production is improved, conditions are brought about that are likely to favor destructive insects and to provide them with better means of becoming a constant menace. This fact should not be overlooked as we go forward in our technical assistance planning. Few farmers in the underprivileged areas of the world have any conception of the losses that result from insect attack. And even if they do, there has been little that they could do to fight back. I have always felt that, if we could find ways and means to protect from insects and diseases the crops now being grown, that alone would increase production to the point where we would no longer need to fear food shortages. The Food and Agriculture Organization of the United Nations has estimated that in a single year the losses caused by rats, insects, and fungi to stored grains and rice alone totaled about 33 million tons in the world's granaries. This is enough food to keep 150 million people alive for a year.

Reports like these are focusing attention on how insect control projects might be included in programs of technical collaboration. Entomology can and will play a more important part in technical assistance if given the opportunity. Fortunately it has already clearly demonstrated its value.

During the past 10 years the United States Department of Agriculture and the ministries of agriculture in half a dozen countries of Central and South America have conducted joint programs of technical cooperation. This work is now a part of the Point Four program. Entomological assistance has been provided these countries by giving technicians specific assignments on a short-term basis. They have aided on such problems as the migratory locust; insects affecting cotton, coffee, citrus, and lemon grass; insects that plague stored grain; insects that carry human diseases; and livestock pests.

In most Latin American countries, raising livestock is one of the chief activities and is essential to their economy and well being. In Colombia alone there are more cattle than people. Two of the most serious cattle pests in the southern hemisphere range all the way from Mexico to Brazil. These are the cattle tick, *Boophilus annulatus* var. *microplus* Can., and the human warble or torsalo fly, *Dermatobia hominis* (L. Jr.). No loss figures are available, but we know that the losses caused by these pests to hides and to beef and milk production are tremendous. Mortality among calves may be as high as 70 percent in some of the more heavily infested areas of Central America.

Until the advent of DDT and other chlorinated hydrocarbon insecticides, livestock producers relied entirely upon arsenical dips for tick control. In recent years these materials have not been as effective as before and specialists have expressed the belief that the cattle tick has developed some resistance to arsenicals. For the torsalo fly, no solution had ever been found to combat either the fly or its grub, which lives under the animal's hide.

In 1948 a United States Department of Agriculture entomologist went to Brazil under the auspices of the American International Association for Economic and Social Development to test several of the new insecticides and rotenone on the control

*Adapted from a paper read before the 36th annual meeting of the Pacific Branch of the American Association of Economic Entomologists, Santa Barbara, Calif.

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Iraqi locust fighters spread poisoned bran across desert sands. Such methods of control are now being supplemented by aerial spraying and other mechanized means.

of livestock pests. Several months after he had left Brazil, it was discovered that wherever applications of a 0.5-percent toxaphene emulsion concentrate had been continued for a period of 5 months, there was a noticeable decrease in the incidence of torsalo warbles. There was no experimental evidence to the effect that toxaphene was toxic either to the young grubs as they entered the hide or to the encysted older grubs, but it was the general belief that the residual toxaphene was killing off the flies and mosquitoes that serve as vectors for the eggs of the female torsalo fly.

On the basis of these developments, Point Four technicians in February 1950 set up toxaphene-spray demonstrations in Nicaragua and Ecuador. They found that in 8 months treated animals gained an average of 139 pounds more than the untreated. They also found that the torsalo fly could be satisfactorily controlled by eliminating its dipterous vectors; at the same time ticks and several species of other miscellaneous flies were likewise affected.

Wherever this work has been demonstrated, enthusiasm reigns throughout livestock circles of Latin America. Both large and small producers, individually and collectively, have started campaigns. The Ministries of Agriculture of Costa Rica, Nicaragua, Panama, and Ecuador are developing their own services and lending support to cooperating agencies working to bring these pests under control.[1] The success of this work has led to the development of a full-time regional project in Central America and northern South America. The entomologist assigned to the project has completed 1 year's work in Costa Rica and is now preparing to carry on similar work in Ecuador and the

[1] For the story of torsalo control in Nicaragua, see "Torsalo in Nicaragua," by Keith Himebaugh, *Foreign Agriculture,* June 1952.

other countries. He has emphasized tick and torsalo control and has helped train native technicians, extension workers, and farmers in practical and safe methods of treating livestock for parasite control.

Point Four entomologists are now stationed in El Salvador, Nicaragua, Bolivia, Ecuador, and the Dominican Republic, and will soon be sent to Peru and Brazil. These men are being confronted with the varied insect problems of cotton, coffee, citrus, corn, tobacco, and other miscellaneous crops and livestock. They conduct research, train local assistants in the fundamentals of entomology and the use of insecticides, and carry on extension activities. They are accumulating a wealth of information on the local flora and fauna, which until now have been too little understood for even our own needs in the United States and still await further exploration in many fields. This cooperation is a challenging experience that is rapidly paying dividends in an improved agriculture at the same time that it is stimulating the interest of United States industry in exporting insecticides and spray and dusting equipment.

A move is now on to set up a regional project in Panama for introducing, propagating, and distributing parasites and predators of crop pests, especially pests that affect sugarcane, coffee, corn, cotton, coconuts, fruits, and vegetables. This would be a cooperative project involving the United States Department of Agriculture, the Panamanian Ministry of Agriculture, and the Technical Cooperation Administration of the United States Department of State. Considerable attention would also be given to developing cultural methods for insect control and to other practices that would tend to minimize the need for insecticides.

A laboratory established near the Panama Canal would serve as an advance post for the entire Western Hemisphere. It would reduce the probability that new insect pests would be introduced as a result of commerce through the Canal.

In the Eastern Hemisphere Point Four aid in the control of agricultural pests has been confined largely to an attack on the desert locust, *Chistocerca gregaria* (Forskal). Entomologists are now being recruited for India, Iran, and Iraq for general entomological and extension work. Point Four entomologists are already on duty in Liberia, Nepal, and the Philippines.

Point Four is authorized to provide locust control aid only upon request from, and under bilateral agreement with, individual countries. The purpose of its locust control program is to assist locust-infested countries by supplementing local control activities, by demonstrating aerial spraying methods, and by training local pilots how to fly and operate spraying planes. The United States program is coordinated with the locust-control programs of the Food and Agriculture Organization of the United Nations; to avoid overlapping of work, technicians of the British and local control units are cooperating with others in the field. FAO in Rome serves as a clearinghouse for all national and international locust-control activities.

Iran recently was the scene of a 7-country program that will probably go down in history as one of the finest examples of international cooperation in pest control.[2] There India, Pakistan, Turkey, Italy, the Soviet Union, and the United States cooperated by supplying insecticides, bran, spray equipment, trucks, jeeps, and planes. In addition, the United States supplied technical knowledge, furnished two entomologists and the pilots who flew the planes.

The locust control in Iran began after operations had been under way in Iraq and Jordan for nearly 2 months. Swarms of locusts moving northward from the Arabian Peninsula fanned out through the Kuwait Province, Iraq, and into Jordan. These locusts joined escapees of the past season to cover large areas in Iran and Pakistan. Although the situation was critical and the task a tremendous one, every effort was made to win the fight. At the same time, preparations were made to continue the fight into Pakistan, India, and Afghanistan during the summer. This fall, control work will probably be undertaken in Yemen, Ethiopia, and, possibly, the Arabian Peninsula.

This project is accomplishing more than killing locusts. It is warding off starvation. It is instilling confidence in people with whom we have had little contact in the past. It is making friends and good will for us. It is proving that cooperation among nations is vital even when it comes to protecting farm crops from insect plagues.

But agricultural pests are not the only ones that harass the world. For many years we have suffered from infectious human diseases that are insect-borne and by that means have been imported from one place to another. Yellow fever and malaria are

[2] For information on last year's anti-locust campaign in Iran, see "Cooperative Campaign Fights Iran's Locusts," by Edson J. Hambleton, *Foreign Agriculture,* July 1951.

A mixture of diesel oil and DDT is sprayed on stagnant water in Liberia to control the mosquitoes that carry malaria.

good examples, both carried from victim to victim by mosquitoes. Everywhere, the problems of health and agriculture go hand-in-hand. Although in most countries medical science has advanced more rapidly than entomology, it is only in recent years that an attempt has been made to control some of the pestilential diseases that still sweep through large areas of the world in epidemic waves. Vast areas of the world remain undeveloped and their splendid resources are denied to mankind simply because of diseases that are rampant. These must be controlled if economic development is to succeed. Health authorities, like entomologists, are concerned with quarantines, which have served a useful purpose in preventing the spread of disease from country to country. The development of faster means of transportation, however, is limiting the effectiveness of quarantine protection; and attention is now being given to regional programs designed to attack and eradicate certain diseases at their source. This is a most constructive approach in the international health movement of today, in which collaboration toward a common goal has been really magnificent.

Our first efforts in bilateral cooperation in health began nearly 10 years ago, when a program was launched by the Office of the Coordinator of Inter-American Affairs in 18 republics of Latin America. Major emphasis in this program has been given to controlling insect-borne diseases such as malaria, typhus, and plague. During this period, too, the threat of yellow fever has been greatly reduced in the Western Hemisphere by the Pan American Sanitary Bureau. Its campaign to eradicate the yellow fever mosquito, *Aedes aegypti* (Linn.), is having noteworthy success.

One of the biggest tasks that lay ahead when the program of economic aid to Greece and Turkey was initiated in 1947 was the control of malaria. So successfully was it carried out that the disease, once a major problem in Greece, is now of minor significance. Throughout the Middle East and south and southeast Asia malaria-control projects have included extensive DDT residual spray operations and the distribution of chloroquinine. Hundreds of thousands of dwellings of one kind or another have been sprayed in an effort to relieve the suffering of the people. American experts supervise these malaria-control teams; they train workers and provide technical guidance and assistance to governments in developing adequate health services. In Iran alone last year 15,600,000 square meters of building surfaces were covered with a residual DDT spray, in a campaign that extended to towns and villages with a total population of nearly 450,000. In Pakistan, a malaria-control project that has been running for 2 years not only has brought about a drastic reduction in the malaria rates but at the same time has substantially improved the health and vigor of agricultural laborers. The story is the same wherever entomologists carry on their fight against insects: increased productivity of farmers and their fields follows in the wake of pest control.

The Volga-Don Irrigation Project*

The ship canal between the Volga and Don Rivers, which was formally opened on July 27, 1952, is more than a link in the waterways of the Union of Soviet Socialist Republics. It is also a part of the large network of irrigation canals that is being constructed for the arid and semiarid regions of the Stalingrad and Rostov Provinces. This year, reports say, enough of the network has been completed to irrigate some of the cropland in the Rostov Province along the lower Don River. Until now, all irrigated agriculture in the USSR, with certain minor exceptions, has existed only in the cotton-growing regions of Central Asia and Transcaucasia.

The Volga-Don irrigation network is one of the "Great Construction Projects of Communism" announced and acclaimed throughout the Soviet Union in the latter part of 1950. These projects include 2 huge hydroelectric stations at Kuibyshev and Stalingrad on the Volga River, a 650-mile irrigation canal from the Amu Darya River to the Caspian Sea in Western Turkmenistan, and a 300-mile irrigation canal from Zaporozhe on the Dnepr River in southern Ukraine to Kerch in the Crimea—all with their accompanying irrigation systems.

All of these projects are scheduled for completion before or during 1957. Together, they are to irrigate nearly 15,000,000 arid and semiarid acres throughout the USSR. In addition, they will be supplemented by "water-conservancy" programs, which will benefit 55 million acres more. Included in these programs will be wells, ponds and basins built to take advantage of seasonal precipitation, and various means of utilizing the seepage from irrigation systems and the overflow from all types of reservoirs; these are expected to maintain pasture and support the growth of wild hay.

The Volga-Don irrigation project, first in the series to be partly completed, has as its final goal the irrigation of 1,850,000 acres in the Rostov and Stalingrad Provinces. In addition, 5,000,000 acres are expected to benefit from a supplementary system of water conservancy.

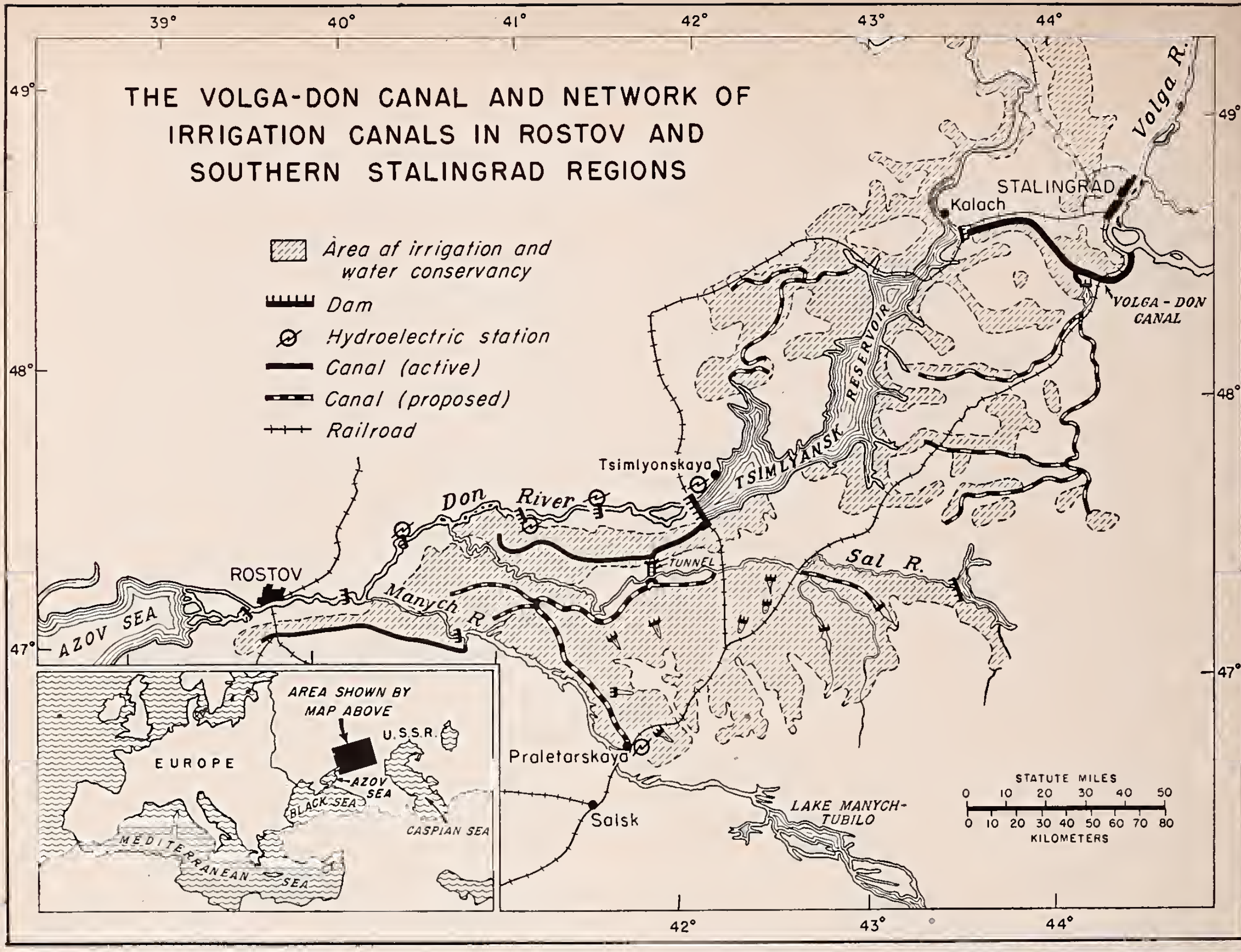
Parts of the system finished to date are the Volga-Don ship canal; the Tsimlyansk Reservoir; and 120 miles of major irrigation canals. These last are a section of the main Don canal, from the Tsimlyansk Reservoir to the point of the projected tunnel under the Sal River, and two distribution canals—the Lower Don canal extending westward from the Don main canal along the Don River, and the Azov canal extending westward from the Manych River reservoir to the Sea of Azov. It is reported that thus far 1,665 miles of irrigation canals have been completed in the project; presumably these figures include all channels, large and small. Still uncompleted are the greater part of the Don main canal (all the sections extending southward from the tunnel) and 5 distribution canals. Most of the area to be irrigated by the system must wait upon the completion of these canals. All in all, the finished project will include 470 miles of major irrigation canals, 140 pumping stations, and 5 hydroelectric stations.

Construction of the Volga-Don ship canal has been on the minds of Soviet planners for a long time, and work was actually begun on it before World War II. Progress halted during the war with the heavy military operations around Rostov and Stalingrad, and presumably renewal of the project was delayed by postwar reconstruction in the area. In December 1950 the canal was once more announced as a construction project, this time with irrigation facilities added. The year set for com-

TABLE 1.—*Areas to be benefitted by the various projects in the Soviet irrigation program*

Project	Area to be irrigated		Area to benefit by water conservancy		Construction period
	1,000 hectares	*1,000 acres*	*1,000 hectares*	*1,000 acres*	
Volga-Don canal	750	1,850	2,000	5,000	1951-56
Kuibyshev dam	1,000	2,500	—	—	1950-55
Stalingrad dam	1,500	3,700	11,500	28,400	1951-56
Turkmen canal	1,300	3,200	7,000	17,300	1951-57
So. Ukrainian and No. Crimean canal	1,500	3,700	1,700	4,200	1951-57
Total	6,050	14,950	22,200	54,900	

*Prepared in the Regional Investigations Branch, OFAR.



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pleting the canal was 1952; for the entire project, 1956.

The ship canal joins the two great rivers of European Russia. Thus it unites the seas of the country into one waterway, connecting the Baltic and White Seas in the north and the Caspian Sea in the south with the Sea of Azov and the Black Sea, and opens the Volga system into the Mediterranean. It is the final link in the huge system that began with the canal between the White and Baltic Seas in 1933 and the Moscow Canal in 1937.

It extends 63 miles in an S-curve from Stalingrad on the Volga to Kalach on the Don. To cross the divide between the two rivers, which is 144 feet above the Don and 289 feet above the Volga, 13 locks were necessary—9 on the Volga side and 4 on the Don side. Three reservoirs were formed from streams in the trace of the canal, so that only 32 miles of channel had to be built.

What proportion of forced labor was used in building the canal is not known; but such labor has predominated in other large construction projects in the USSR. The Soviet press, apparently trying to suggest that little or no forced labor was used, has emphasized the considerable use of heavy machinery; it has also portrayed the canal as entirely the product of spontaneous popular action. Some conclusions as to the popularity of the canal, however, may be drawn from the fact that neither Stalin nor any other member of the powerful Politburo attended the official opening of the canal, which is named after Lenin.

The Tsimlyansk Reservoir, or "sea," as the Russians term it, was built in order to maintain the navigability of the Don River between Rostov and the ship canal. The reservoir, which is about 90 miles long and 24 miles wide at its widest part, was formed by building an earth-filled dam in the Don River at Tsimlyanskaya, about 90 miles below the canal. The dam itself is about 7 miles long, 105

feet high, and wide enough to accommodate a railroad and a paved highway; its northern end is a hydraulic dam of reenforced concrete 540 yards long, which includes a fish ladder and 2 locks. It is claimed that ships can complete passage through these locks in 12 to 18 minutes.

To clear the more than 700 square miles required for the Tsimlyansk Reservoir it was necessary to move 49 communities in the Rostov Province. In the Stalingrad Province, transfers involved 2 towns, more than 9,000 peasant homes, as well as the property of 71 collective farms, 6 machine tractor stations, and 727 public buildings.

Water from the Tsimlyansk Reservoir will be used to irrigate the semiarid steppe lying south of the Don River, including the valleys of the Sal and Manych Rivers, as well as some of the area in the Stalingrad Province. In addition, the large hydroelectric station, which has a power capacity of 160,000 kilowatts and a planned annual output of 500,000,000 kilowatt hours, will provide electric power for agriculture and industry; it will be augmented by several smaller stations in the region. In this connection it should be mentioned that one feature of the Volga-Don irrigation project is the emphasis on electro-machine-tractor stations. Two organizations of this new type have already been set up, and the plans call for many more as power from new hydroelectric stations becomes available. Through the assistance of these stations, it is said, farm operations like plowing, drilling, cultivating of fallow and row crops, stubble mulching, and harvesting are to be performed with electric tractors or electrically powered machinery.

Of the area that will benefit from the irrigation and water conservancy facilities of the Volga-Don project, most will lie within the Province of Rostov. Final goals specify that 1,480,000 acres will be irrigated in that Province compared with 370,000 acres in the Stalingrad Province. Of the total in the Rostov area, only about one-third will be irrigated by gravity flow; the rest will require mechanical lift. To execute this enormous task, the plan calls for 80 pumping stations. Already, 7 of them, with a total of 22 pumps, have been constructed. In the Stalingrad area, 264,000 of the irrigated acres will receive water from the Tsimlyansk Reservoir, and the rest will be supplied from the Volga-Don ship canal. With what canals have already been completed, 250,000 acres are said to be under irrigation in the Rostov area this year. In 1953, it is expected 250,000 more acres will be brought under irrigation in that Province and 60,000 in the Stalingrad Province. Only time will tell whether the goal of 1,850,000 irrigated acres is to be attained.

As far as the supplementary water-conservancy projects are concerned, 250,000 acres in the Rostov Province are reported to be already enjoying the benefits of them. Next year the goal is 620,000 acres in the two Provinces together, all but 125,000 of them in the Rostov Province.

Most of the area to be irrigated in the two Provinces is part of the steppe between the Azov and the Caspian seas, a semiarid region of low precipitation and frequent droughts, relatively flat, all of it less than 500 feet above sea level. Average weather observations for the area are available only for the two major cities, but these probably represent the range of conditions well enough. The growing season is short, extending from the middle of April to the middle of October; at Stalingrad it lasts 177 days; at Rostov, 184. Annual precipitation is 14.6 inches at Stalingrad; 18.5 at Rostov. Temperature during the warmest month is 76.5°F. at Stalingrad and 75° at Rostov; during the coldest month, 14° at Stalingrad and 21° at Rostov.

As a result of these poor growing conditions, crop yields in the area have been consistently low. The predominant crop is spring wheat, followed by winter rye and winter wheat. In 1928-32, the officially reported average yield of spring wheat for the Lower Volga territory, which then included the present Stalingrad Province, was only 7.6 bushels per acre; for the North Caucasus territory, which included the present Rostov Province, it was 8.6 bushels. In 1933-37 reported yields were somewhat higher—7.9 bushels in the Stalingrad Province and 9 to 10 in the Rostov Province—but the increase was probably due to the fact that in 1933 the Soviet authorities ceased to report crop production in barn yields and began instead to report it in biological yields—i.e., as estimated yields in the field before harvest—a practice that results in figures 10 to 20 percent higher. In 1931 the average yield of spring wheat in the Lower Volga territory was less than 5 bushels per acre, and yields almost as low were reported again in 1932 and 1936.

For both climatic and economic reasons it seems likely that the greater part of the area affected by the new irrigation project will be designated for growing spring wheat. Not only is that crop well adapted to the conditions prevailing in the

area, but increased production of bread grains is vital to the USSR.

Official goals for grain yields in various regions of the Soviet Union were recently announced for the 1951-55 Five-Year Plan. Goals for the Stalingrad region for irrigated wheat were stated as 39 to 43 bushels per acre; for the Rostov region, as 45 to 50.

No doubt irrigation will substantially increase yields and stabilize production of wheat and other crops in the semiarid regions of the USSR. Fokeyev, in *Sovietskaya Agronomiya* for March 1951, reports that the *sukhovei,* or hot dry winds from the desert, which often play havoc with the crops, do not have such harmful effects on irrigated wheat. Another factor that will contribute to increased yields is the introduction of new wheat varieties not subject to lodging. Nevertheless, the very high goals sometimes cited in Soviet sources appear to be unrealistic. Besides, much will depend on farming and irrigation practices, and past experience of the Soviet Union suggests caution in assuming that these practices will be generally efficient.

Japanese 4-H Club Projects

By DAVID Y. TAKAHARA

Japan's 4-H Clubs are only 3 years old but already they can count their members by the thousand. Much of the popularity that the clubs enjoy springs from their being geared to the farming pattern of the country.

Japan's farms are small—most of them are no more than 2½ acres in size—and farm income is not large. Most Japanese 4-H boys and girls therefore choose projects that are small and inexpensive. They raise chickens, rabbits, and goats instead of cattle and swine as so many American 4-H boys and girls do on the larger farms of this country.

Angora rabbits are especially popular among the Japanese 4-H Club members because the rabbits bring a quick cash return. The fur can be made into gloves, scarfs, etc., for export. The boy who won the demonstration contest in the National 4-H Club Congress this spring—the first held in Japan—chose angora rabbits as his project. Some of the 4-H Club members in northern Japan make slippers of "wangle" reed during the slack farming season. Some members dry persimmons and process them into a special product that will bring in much more cash than the raw persimmons.

A project that is highly popular among 4-H Club girls is kitchen improvement. Most Japanese farm homes have dark, inconvenient kitchens that the girls wish to redo for the sake of efficiency and family welfare. Rebuilding or putting in a new "kamado"—a kind of kitchen range built of stone or brick—is generally the first step in kitchen improvement. With this improvement, cooking becomes easier, and fuel is saved.

Membership in the 4-H Clubs is limited to boys and girls from 10 to 20 years old. For young people from 21 to 30 years of age, Japan has Agricultural Study Clubs that differ from the 4-H Clubs in little but age level. The 30,000 4-H and Agricultural Study Clubs formed in the past 3 years now have a million members among the Japanese rural youth.

Angora rabbits are a favorite project of Japanese 4-H Club boys and girls.

Mr. Takahara is Director General, Japanese 4-H Club Association, Tokyo.

Biometry, New Tool for Progress In Underdeveloped Areas

by HENRY HOPP

Biometry is a young science; scarcely a half-century has passed since it was formally recognized. It is the science of how to set up research—how to design and analyze experiments and surveys so as to get reliable and accurate results at a minimum of expense. As such, it is a useful tool for technical workers in underdeveloped areas of the world. For, in the typical underdeveloped area, the technical problems are multitudinous and the resources available to solve them are meager.

Biometry has another fundamental value, however, that is even more important to the long-range objectives of technical assistance programs like Point Four. It has a value in the training of young nationals, those who are being groomed to carry the load for future agricultural progress in their respective countries. Peoples of less developed areas characteristically rely on intuitive and empirical approaches to their problems; and these fundamental mental barriers to progress must be overcome. Often these attitudes are ingrained by centuries of custom. They constitute a problem that almost every Point Four program must face.

The problem must be realistically met. A body of national technicians must be trained in factuality rather than intuition as a basic operating procedure. Biometry turns out to have a value in this training beyond the prosaic details of experimental design and statistical analysis: it provides a methodology for objective thinking. It inspires technicians to evaluate and solve problems impersonally and critically, to demand solid facts as a basis for action. In progressive areas these concepts are recognized as important to continuing advancement. In backward areas, however, they are revolutionary.

An example of how biometry trains people to think objectively came recently from the tropical research station at Pichilingue, Ecuador, which operates under Point Four. The station had under way a project to increase corn production by selecting high-yielding plants. It ran a preliminary test with seed from 16 plants selected for their high yields: 27 plants in a plot repeated, or replicated, 6 times for each of the 16 selections, a total of almost 3,000 plants. When it became clear that results were promising, it was decided to continue the research in the next crop season, but not to expand it beyond its original size. The questions of the plant breeders—"Can we not determine *objectively* how to get the most genetic improvement in corn with our limited facilities? What is the most efficient number of plants and plots to have in this project?"—were answered by the biometrician. With his calculations he soon explained to his coworkers the most effective use that could be made of the available land: increase the selections from 16 to 200; reduce the replications from 6 to 5; and reduce the number of plants per replication from 27 to 3. Result of the biometrician's calculations: no more than 3,000 plants, but an expected genetic improvement that was 40 percent higher.

Early in the Point Four program, administrators saw the need for good biometrical methods in cooperative agricultural projects. As a result, a consulting biometrical service was established in the United States Department of Agriculture in Washington. Through it, advice in planning research and demonstration tests has been constantly available to technicians in the field, both those from the United States and those from cooperating countries; and these men have made gratifying heavy demands upon it. One of its features is that it makes statistical analyses of research data gathered in the field.

Such biometrical service has created among technicians an appreciation of the value of having correct design for their experiments, especially when they have seen that such experiments often mean less work.

This work-saving facility of biometrical design

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is being exemplified in the coffee selection programs being carried on at the agricultural stations in Guatemala, El Salvador, Nicaragua, and Costa Rica. All of these programs seek high-yielding varieties but, until last year, each country operated its program in a somewhat different way. Last year, when these 4 countries decided to integrate their separate programs, they called on a biometrician to guide them in setting up their experiments. He showed them that they did not need to set out as many trees per plot as they had hitherto —some plots had been planted to as many as 100 trees. The optimum number, he found, was only 4. What this reduction will mean in lowered costs—of money, facilities, and sheer labor—is emphasized by the fact that it will take many years for the coffee trees to grow large enough to show their relative values.

Demands upon Washington's Point Four biometrical service for agriculturists have burgeoned in the past years. Additional provision has had to be made to meet these demands. In some of the countries where large research programs have been developed, biometricians are being employed by the field stations to serve local needs. In others, the Office of Foreign Agricultural Relations is offering short-term training courses in biometry to technicians in the field.

The first of these short courses was give in January of this year at the Centro Nacional de Agronomía, the Point Four cooperative station in El Salvador. Eighteen technicians attended and certificates were awarded at the end of the course. The second was held in April at the Point Four colonization project in Tingo María, Peru. The 14 technicians attending came from that project, from the agricultural experiment station at La Molina, and from the Estanco de Tabaco, the government agency responsible for tobacco production. Beginning late in April, a week-long series of seminars were held at La Paz and Cochabamba, Bolivia. Forty technicians of the Servicio Inter-Americano Agrícola, that country's Point Four agricultural program, attended.

All three of these courses were given at the request of the cooperating countries. They were designed to acquaint technicians in the various agricultural branches with the more general types of experimental design and analytical procedures, rather than to train biometrical specialists.

The effectiveness of short-course training depends, however, on the further availability of biometrical consultants. For this reason several countries have sent their technicians to the United States for advanced training in biometry. These technicians return home as consulting biometricians. Availability of such a consultant is good assurance to a country that its research is reliable.

In fact, the reliability that use of biometrical principles gives to research is one of the aspects of biometry that enhance its value to the technician, especially to the technician working under Point Four, who is responsible for recommending tried and true practices to the farmer. He knows too well what the effect would be if he recommended a practice that failed. The very success of Point Four in a country may hinge on the extent to which such mistakes are avoided; and the technician is obliged to "make sure" before he recommends.

In Cuba, where that country and the United States are working together to develop a new source of soft fiber for this hemisphere, technicians are "making sure" of the most efficient method to defiber kenaf, the fiber plant that has been selected for development. They early planned a series of tests on the chemical extraction of kenaf fiber using various solutions, temperatures, and other variables. Their equipment was not capacious, however, and the amount of work that could be done at a time was limited. In all, the original plan called for 3,785 extractions, a number that not only would have required much work but, more serious, would have extended the study over such a long period of time that the kenaf material in the different extractions would not have been comparable. Even if the tests could have been begun while the kenaf plants were very young, the plants collected for the last tests would have been mature. Thus differences among the various extractions would have been confounded with the age of the kenaf and could not rightfully have been attributed to the chemical solution, or to the temperature, or to any one of the other variables.

The technician in charge, well aware that an experiment that confounds the effects of one factor with the effects of others cannot give reliable results, sought biometrical advice. The biometrician found that the whole experiment could be conducted in only 519 extractions, a reduction of 85 percent from the number originally planned. The new plan, which greatly reduced the time required, avoided the use of plants with extreme age dif-


Members of the staff of the Centro Nacional de Agronomía, El Salvador, prepare an assignment for a short course in biometry.

ferences. In fact, the biometrician redesigned the experiment in other ways, too, so that all the differences due to age could be separated from the extraction effects.

As Point Four agricultural programs make progress in introducing better agricultural practices and crops, their research problems become more complex. As advances are made in getting better varieties of corn, for example, difficult problems in corn breeding develop. To meet these increasingly complicated problems, the Institute of Statistics of North Carolina has been making its biometricians available to Point Four programs under a contract established in 1951. This Institute has aided in planning such diverse research as the kenaf experiments in Cuba and the coffee-selection program in Central America.

As one considers the many developmental programs started by the nations of the world under the stimulus of international cooperation, it becomes apparent that a world-wide agricultural revolution is in the making. A strong start has been made in the development of agricultural technology in many areas where little or no progress has been made for generations.

As these programs face the responsibility of performing the research requisite to sound advancement, workers in these programs become aware of the need for using efficient research methods. Thus a considerable demand is developing for training in the applications of biometry to problems of underdeveloped areas. At the same time it has become apparent that some of the crops in these areas, such as coffee and cacao, present special problems of application of biometrical technique. Proposals are now being considered by the Point Four program and the Organization of American States to establish a center for applied biometry in the American Tropics. Such a center will go far to meet the need for men and women trained in the design of research. Cost of this training, it may be confidently anticipated, will be more than offset by the contributions that the trainees will make to research and progress when they return home.

Bolivian Phosphate Discovery May Boost Country's Agriculture

By FRANK J. SHIDELER and WILLIAM L. PRITCHETT

If the farmers in a State the size of Kentucky had only 250 tons of superphosphate fertilizer to use this year in producing their major crops, it would be considered an agricultural crisis. But Bolivian farmers, cultivating an acreage estimated at about the same as the harvested acreage of main crops in Kentucky, will have available not quite 250 tons, which is something like 1/1,600 of the amount used in Kentucky in 1949, for soils that have been producing crops for a much longer time.

The fact that superphosphate is scarce in Bolivia does not mean that the country's soils need little of the fertilizer. They need it greatly, for they are low in native phosphorus: chemical analyses of hundreds of soils samples from various parts of Bolivia show an average of only about 15 pounds of available phosphorus per acre for the highland soils and not much more for the soils in the lower semitropical areas. Rather, superphosphate is scarce because very little phosphate is produced in Bolivia —only 80 to 100 tons this year—and because importation costs are almost prohibitively high in that land-locked country.

There is real hope, however, that soon Bolivia's superphosphate supply will be many times 250 tons. Last year, one of the few phosphate deposits on the South American continent was discovered between Potosí and Sucre, Bolivia. It has been estimated that the deposit contains more than 1 million tons of tricalcium phosphate; this amount, in view of the shortage of phosphate in Bolivia and the growing demand for it, probably means that the deposit is large enough for commercial development. Although the ore from the deposit is of low quality (calculated at about 20 percent tricalcium phosphate by a number of chemists), it is hoped that fertilizer can be made from it and marketed at a price sufficiently low to permit its economic use in Bolivia.

The phosphate in this deposit can be made into fertilizer merely by grinding the ore into powder; in fact, a small company is already engaged in doing so and is marketing its product. But the tricalcium phosphate in ground rock is so slowly available to plants on alkaline soils—soils commonly found in Bolivia's highlands—that tremendous applications

Legumes, like those growing here between rows of Bolivian corn, need phosphorus to thrive.

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Wheat in a fertilizing experiment in the Cochabamba Valley. The plot on the right received superphosphate; the one on the left did not.

would probably be necessary to obtain a noticeable increase in crop yield. If the phosphate is to be put into a more assimilable form, it must first be acidulated and made into superphosphate.

An abundant and cheap source of sulfuric acid is necessary for the manufacture of superphosphate from the ore. A company in La Paz now makes a limited quantity of sulfuric acid, and operators say they would expand production if they could be given an assured market for their product. Fortunately Bolivia has a large potential source of acid in the form of hundreds of thousands of tons of pyrite, containing 45 to 48 percent sulfur. This pyrite is tailings from a tin mill in Potosí.

The small company now processing and marketing ground rock phosphate has been informed of the shortcoming of that form of the fertilizer and has expressed keen interest in manufacturing superphosphate. The company does not feel, however, that it can finance the venture without assistance, for it requires rather expensive equipment.

Other problems will no doubt present themselves before the new phosphate deposit is developed. But it is to be hoped that the interest shown in development will be strong enough to overcome the obstacles, for lack of fertilizer is a serious problem in Bolivia. Because of it, the country must import about 80 percent of the wheat it uses, as well as large quantities of other foods and agricultural products.

Preliminary experiments already conducted in the expanding program toward agricultural improvement lead technicians to believe that if 1,000 to 1,500 additional tons of phosphate fertilizer could be imported this year, wheat and potato yields could be doubled—at least on soils of the types that have been tested. In other experiments on an established stand of alfalfa the cost of fertilizer was

paid for eight times over through boosting the yield of hay with 18-percent superphosphate applied broadcast.

The same soil analyses that showed a shortage of phosphorus in Bolivian soils, also showed a shortage of nitrogen. But the deficiency of nitrogen, although a widespread condition, does not present as serious a problem in crop production as the low level of phosphate does. It is a deficiency that can be substantially overcome by proper rotations of crops and by the use of leguminous green manures. In fact, one of the most significant experiments carried out at the experiment station of the Servicio Agrícola Interamericano at Cochabamba involved the use of green manures. Wheat, for instance, showed gratifying increases. Where it was preceded by vetch, it produced 28 bushels to the acre; and where it was preceded by field peas it produced 43 bushels: both yields were in sharp contrast to the mere 11 bushels produced when wheat was planted in plots previously fallowed.

Even the shortage of nitrogen, however, can be indirectly overcome by the use of phosphates, for most soil-improvement crops respond to the applications of phosphate fertilizers.

Scientists in Bolivia know that the introduction of more phosphate fertilizers will not wholly solve the problem of low farm yields. Antiquated cultural practices, poor seeds, and adverse climatic conditions also play a part. But, since phosphate fertilizers seem to be a basic need on Bolivian farms, it is fortunate that the country has materials at hand with which to manufacture its own phosphate fertilizers. If these fertilizers can be produced locally and if they are used in combination with good crop rotations and higher yielding varieties of crops, a big step will have been taken toward attaining more abundant food production and a higher level of living for the people of Bolivia.

Restoring Chocolate's Old-Time Flavor

By ROBERT L. FOWLER and NORMAN W. KEMPF

Chocolate manufacturers, plant scientists, and governments are working together with cacao growers to make the chocolate of tomorrow as flavorful as the chocolate of 50 years ago. Few consumers realize that the flavor of chocolate has changed, for the change has been gradual and manufacturers have been skillful in adjusting their recipes. They have had need for skill: first, the high-quality "flavor" varieties of cacao have gradually been giving way to less flavorsome varieties; second, the old painstaking practices of harvesting and fermenting, which contribute much to full-bodied flavor, have fallen into disuse in many areas. Chocolate manufacturers realize that they can go just so far in adjusting their recipes to these changes and that the eventual solution to their problem lies not in their own laboratories but in the cacao plantations.

The story of what has happened to the flavor of quality cacao in Ecuador is typical of what has happened to flavor cacaos throughout the Western Hemisphere. Arriba Cacao, for instance, which is a product of Ecuador, once had a very high quality. It had a rich, spicy aroma that made it much in demand by chocolate manufacturers for strengthening the flavor of their products. It was dependable and uniform and, up to 1910, was the principal cacao on the market. A good deal of its superiority was due to the fact that it was made up mostly of beans from Cacao Nacional (*Theobroma cacao L.*), which has been grown in Ecuador since before the days of the Spanish conquest and which, because of its plump and richly flavored beans, has been known as the Pride of Ecuador.

Early in the 1900's, however, the quality of Cacao Arriba began to decline. Apparently fewer "flavor" beans were going into it. To compensate for the

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change, manufacturers in the United States changed their recipes, and, by skillful blending with other cacaos on the market, still managed to turn out a high-grade product. After all, they had other flavor cacaos to choose from, such as Estates Trinidad from Trinidad, and Maricaibo, Caracas, and Puerto Cabello from Venezuela; but, as time went on, these too deteriorated. Over the years, so extensive has been the shift to nonflavor cacaos—but not to less nutritious, it must be said—that chocolate now contains about 20 percent of flavor beans instead of the 70 percent it once contained.

What had brought about the change in the quality of Cacao Arriba? For one thing, growers had begun to plant other kinds of cacaos besides Cacao Nacional. The shift began in 1890, when a type known as Trinitario was introduced into Ecuador from the island of Trinidad. Although Trinitario does not have the flavor that Nacional has, it has much to recommend it to growers: it reaches maximum production several years earlier than Nacional does; it yields larger harvests; it can be propagated more easily; it is not so exacting in its requirements. Unfortunately, no one at first paid much attention to the flavor deficiency of the new type, especially since supply was short, demand was high, and the market price was as favorable for ordinary cacao as for the flavorsome Nacional. Little by little, Trinitario beans replaced those of Nacional in Cacao Arriba; later, there were also beans that had been developed through intercrosses between the varieties, but few of them had the fine flavor of the Nacional.

The economic problems that arose between World Wars I and II had further depressing effects on the production of well-flavored cacaos. Diseases, too, plagued the plantations. Cacao growers began to lose heart; many of the most skilled producers left their plantations to less knowing hands. Even with the ensuing decrease in cacao production in Latin America, prices continued to fall: new plantations of ordinary cacao were coming into production in West Africa and Brazil, keeping the supply high.

Before these changes took place, the Ecuadoran cacao grower had taken personal pride in preparing cacao for the market. He had harvested at frequent intervals and gathered only the matured fruit, a precaution he took because unripe fruit lacks the sugar needed for fermentation and contains excessive amounts of tannins, which give a harsh, astringent flavor to finished chocolate.

He had taken special pains with the fermentation process, which brings about chemical changes in the beans and results in the forming of flavor precursors. He had trained his workers carefully in the skills of the process.

He had conformed to high marketing standards, too. Beans were considered suitable for Arriba Cacao only if they had good color, flavor, and odor and were not germinated, diseased, or damaged by insects. Then, when the beans were roasted at the chocolate factory, the characteristic Arriba flavor became pronounced and a good chocolate flavor developed.

Since World War II there have been indications that the best days of cacao production are not all in the past. For one thing, prices have become favorable. Growers have shown a renewed interest in cacao and are bringing many of the abandoned plantations into production.

Cacao Nacional is one of the world's finest flavor cacaos.

Selecting cacao seeds in a plant-breeding program to develop high-yielding varieties.

Many manufacturers are beginning to take an active part in helping the cacao industry get back into high-quality production. They are aware that the principal factors in flavor—variety of cacao, maturity of pod at harvest, and fermentation practices—are in the hands of the grower, and that the only influence the manufacturer can have over them is to encourage the grower to do his part well.

One of the first evidences of this cooperation from manufacturers in the agricultural side of cacao was the establishment in 1947, under their support, of a cacao research center at the Inter-American Institute of Agricultural Sciences at Turrialba, Costa Rica. To date, approximately 50 technicians from various cacao-producing countries have received practical training there.

The manufacturers also have made available the services of their cacao-quality-testing board to research workers in all countries for evaluating the flavor of their cacao selections. Last year one of the chocolate manufacturers sent a specialist in the preparation of cacao to Brazil to help technicians there determine the causes of poor quality of cacao offered for sale in that country. Still another evidence of the manufacturers' interest is the American Cacao Research Committee. This organization was set up by the chocolate manufacturers to obtain production statistics and general information about the growing of cacao.

In this campaign of improving the taste of chocolate, growers and manufacturers are receiving the aid of plant scientists in trying to develop a cacao that will meet the requirements of the grower for a high-yielding, disease-resistant cacao that is easy to grow and yet will give the market a top-quality well-flavored bean. This is a difficult scientific problem. Plants of Cacao Nacional, for instance, are fairly uniform in both productivity and resistance to disease and rarely does one occur that is unusually good in either of these respects. Therefore it is hard to obtain enough superior plants to use in a breeding program. Besides, the propagation of Cacao Nacional by vegetative means is difficult. Should hybridization be necessary to produce plants that combine fllavor with yield, the problem becomes even more complex since flavor cannot be evaluated by external characteristics of the plant. The only way to evaluate the flavor is to taste the chocolate liquor from the toasted bean—and it takes Nacional about 4 years to produce its first fruit!

The cacao-producing countries themselves are also lending support to cacao-improvement efforts. Ecuador, for one, has established a cacao research station, in cooperation with the United States Point Four program. Also under Ecuadoran Government support are several cacao-propagating centers, where progress is being made in producing superior varieties.

Fortunately, the present economic outlook for the cacao grower is favorable and the time is opportune for close cooperation between planter, scientist, and manufacturer. Indeed, the cacao industry may be at the threshold of a new era, an era of profit for both the grower and the manufacturer—to say nothing of the consumer, whose fondness for good chocolate underlies the whole matter.

Indonesian Agricultural Study Published by OFAR

The Office of Foreign Agricultural Relations announces the recent publication of a monograph entitled the "Agricultural Economy of Indonesia" written by John E. Metcalf, staff member of its Far East Division, who has spent more than 10 years in the Far East.

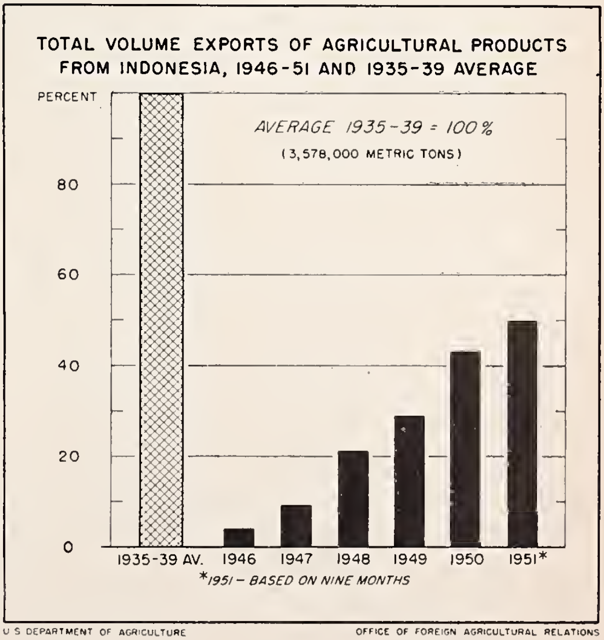
The monograph is the most comprehensive study on the subject in the English language published since the war. The period with which it deals has been a difficult one because of Indonesia's transition from colonial to sovereign status. Indonesia, formerly the Dutch East Indies, did not obtain its independence until 1949. Since then, it has been faced with the great task of re-establishing its economy and building up its agricultural production in harmony with its new sovereignty.

The Republic of Indonesia comprises 4 or 5 large islands and some 2,000 small ones situated astride the Equator just southeast of the continent of Asia. Under Dutch rule for 300 years, these islands developed a unique dual economy—on the one hand, primitive subsistence agriculture employing about 80 percent of the people; on the other hand, a highly specialized plantation agriculture that produced for the export market. But, since the war, production and export of plantation-grown agricultural products have made very slow recovery, as is shown in the accompanying chart, which is reproduced from the monograph.

The reasons for the poor recovery record for Indonesian export crops are set forth in Mr. Metcalf's study. They are a combination of factors, in part resulting from wartime disruption, in part from a rapid population increase and the consequent need to devote a greater area to food crop cultivation.

Agriculture, and all related fields of the national economy, are discussed, such as geography, climate, soils, demography, income distribution, foreign trade, and balance of payments. Considerable attention is given to land utilization and land tenure problems, and to the economic position of the peasant. Government services to agriculture such as rural health, education, extension, and credit are also discussed. Separate sections deal with each important food or commercial crop with special emphasis on techniques of cultivation, production problems, and long-run trends in output.

The monograph, published in September 1952, has 110 pages, 1 map, 4 charts, plus a detailed bibliography. It may be purchased from the Superintendent of Documents, United States Government Printing Office, Washington 25, D. C., for 30 cents per copy.



MIGRATION OF THE LOCUST